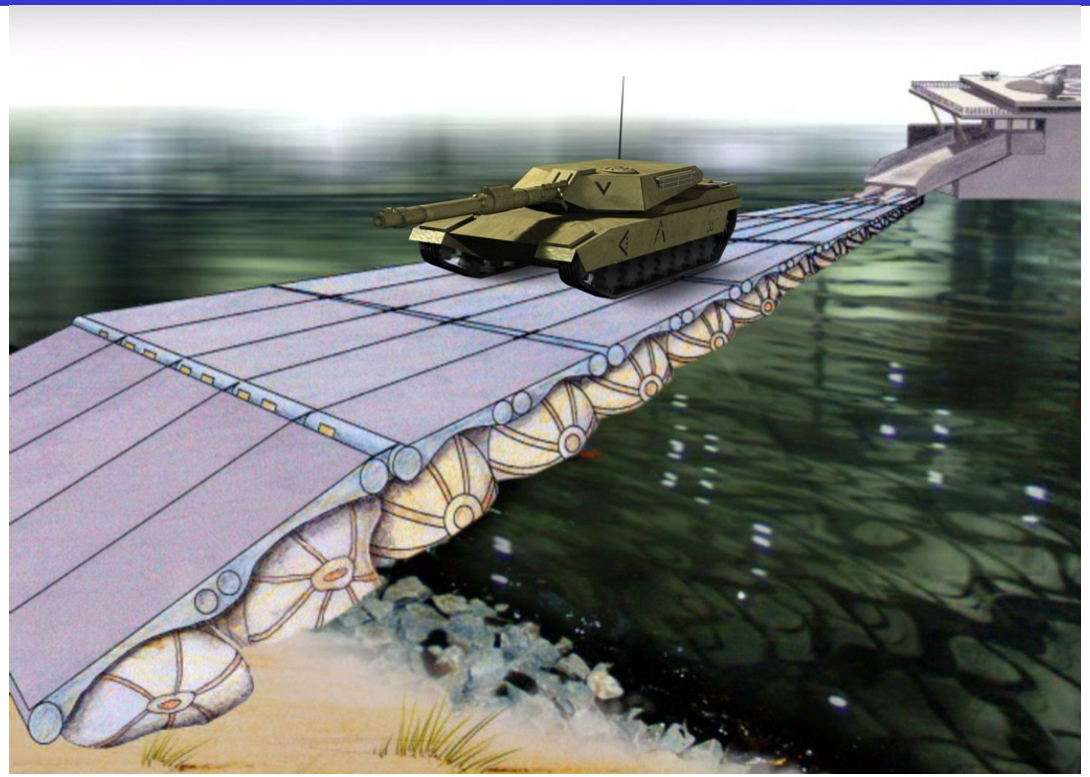
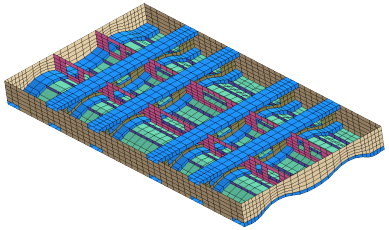
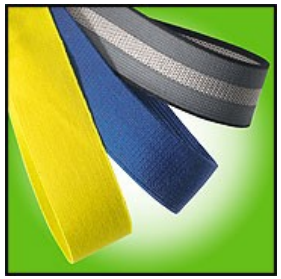
Design Considerations for a Lightweight Modular Causeway Section (LMCS)







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JHSV → Force Projection Enabler
Needs causeway systems for austere SI

Existing Causeway Systems

--- NLS, MCS, INLS ---
all steel barge construction

Not JHSV transportable or deployable

Desired LMCS Features

- **Transportable by and rapidly deployable from TSV/JHSV**
- **Minimal storage/shipping volume**
- **Tailorable to desired gap length**
- **M1A2 payload**
- **No in-water connections**
- **Transportable by primary mover and air lift**
- **Interface with existing JLOTS watercraft**
- **Operational capabilities**
  - **Sheltered ports and harbors**
  - **Sea-state operations**

Primary Design Considerations

Parameter	*LMCS*	*MCS*
Payload	**M1A2 Main Battle Tank**	**M1A2 Main Battle Tank**
Volume	**20 x 9 x 10 for 60 ft** **2400 cu ft per 80 ft**	**(40 x 8 x 9) x 3 for 80 ft** **8640 cu ft per 80 ft**
Weight	**28 tons per 80 ft**	**90 tons per 80 ft**
Transportability	**JHSV**	**Strategic Sealift Ship**
Deployability	**No in water connections**	**Numerous in water connections**
Survivability	**SS 5**	**SS 5**

TWO “NEW” CONCEPTS

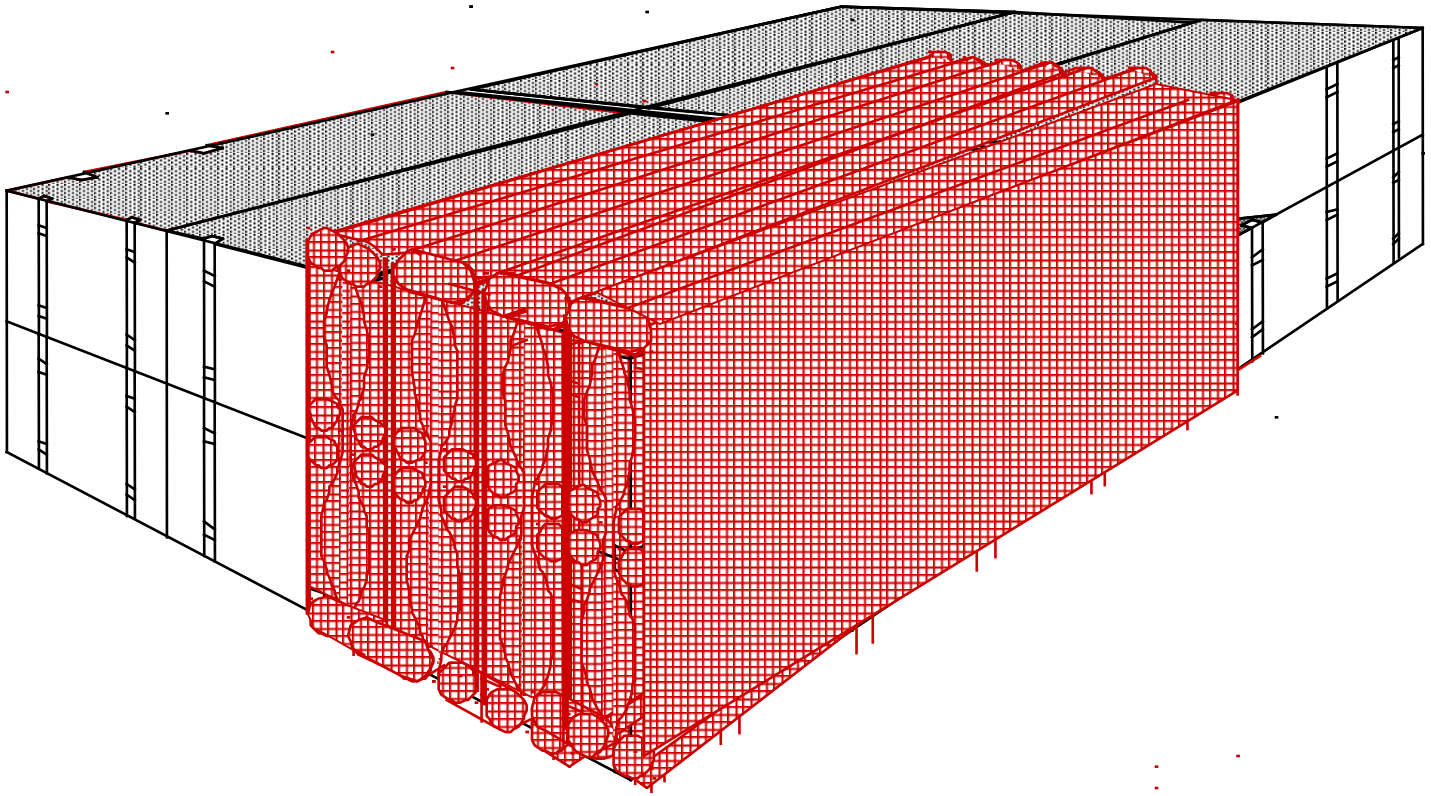
High-strength fiber connections:

- foldable
- maintains stiffness under tension
- adjustable compliancy

Inflatable buoyancy

- reduces internal structure in deck
- minimizes storage volume
- adjusts to sloping bottom

Volume and Weight



LMCS is expected to save 70% in weight and volume compared to existing MCS Causeway while retaining 100% of

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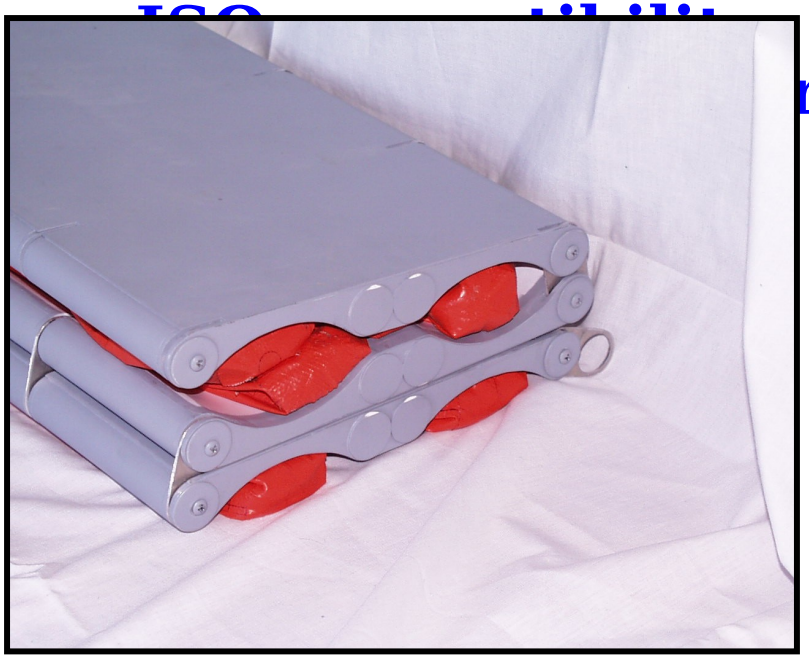
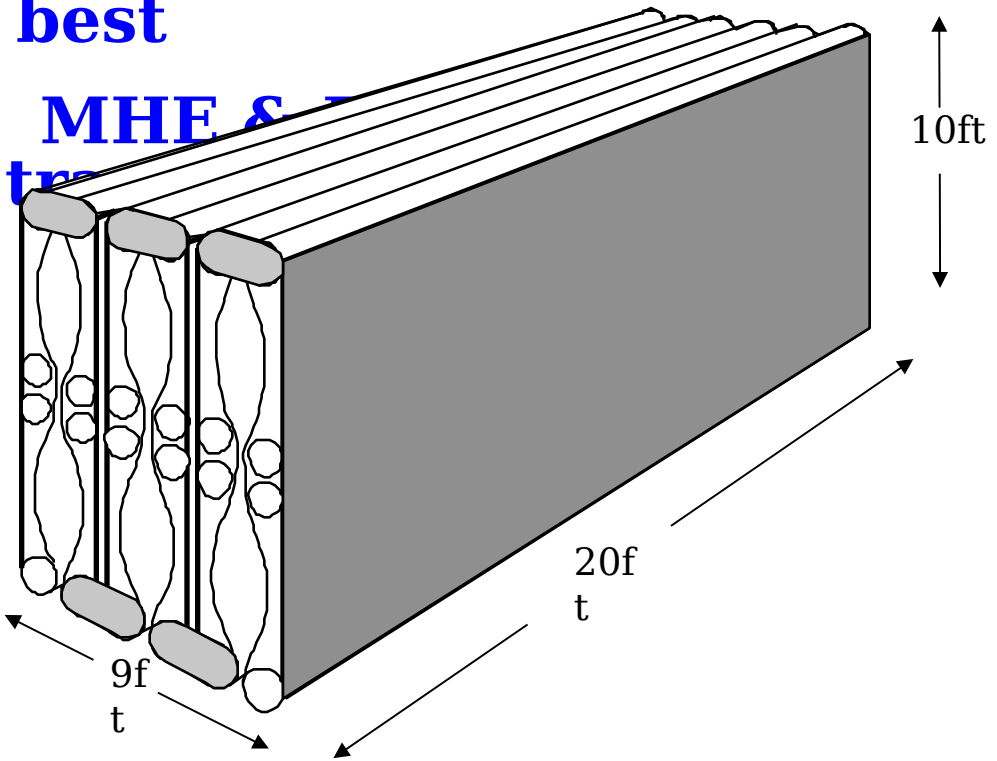
Transportability

36 tons – CH-53E Super Stallion Helicopter

- **Weight of system → Air delivery may be limiting factor**
- **Volume → Stored and shipped configuration – less is best**
- **ISO compatibility - MHE & Tr**
- **Other tr**





Deployability and Recoverability

TSV & JHSV on-board crane limitations

- Weight and size

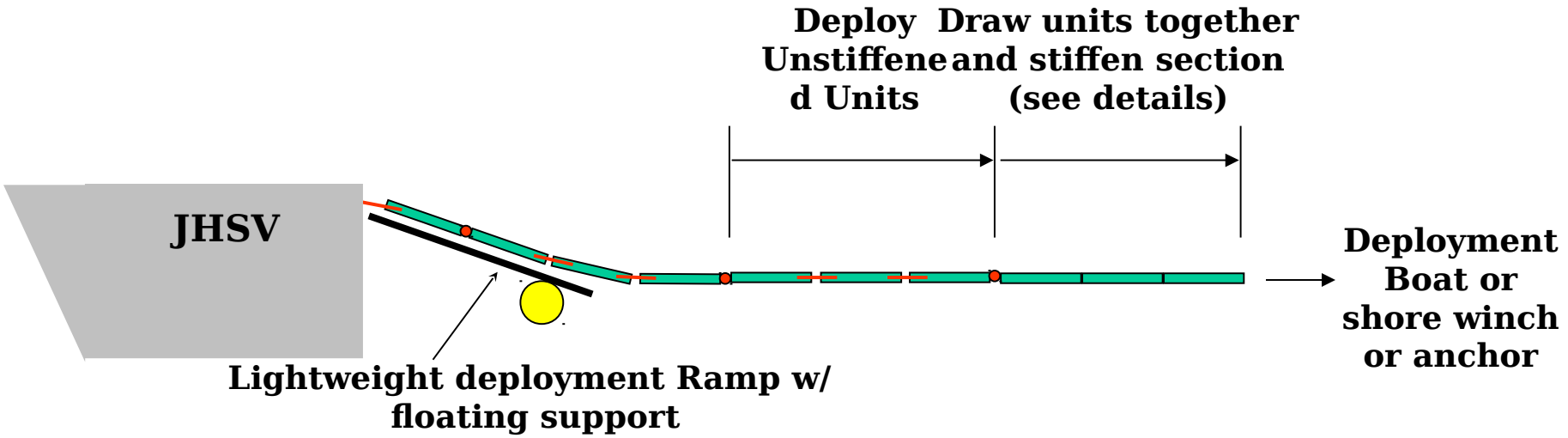
Equipment Requirements

- Large Rigid Hull Inflatable Boat (RHIB)
- Shore-based winch

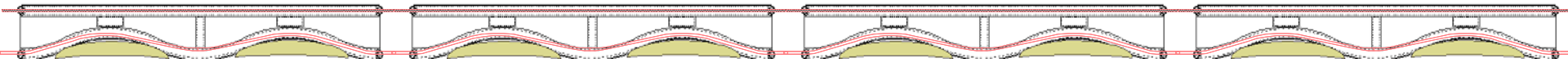
Safety considerations

- No in-water connections
- Minimize assembly time
- Minimize number of personnel
- Simplify mooring system

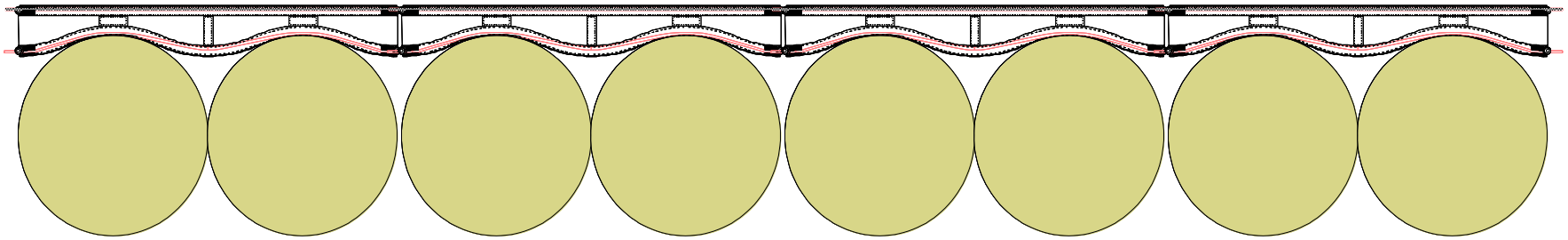
Primary Deployment Option


Deploy Unstiffened Units
Draw units together and stiffen section (see details)
JHSV
Deployment Boat or shore winch or anchor
Lightweight deployment Ramp w/ floating support

- ***Continuous feed from rear of JHSV off ramp or rail system***



Initially loosely connected by high strength straps/cables



On board winch pulls sections together and sets design tension.

Overall stiffness is combination of joint stiffness and module stiffness.

Survivability

- **Floatation**

  - Resistance to puncture/abrasion

  - Contact with sea/river bed

  - Redundancy (2nd internal tube)

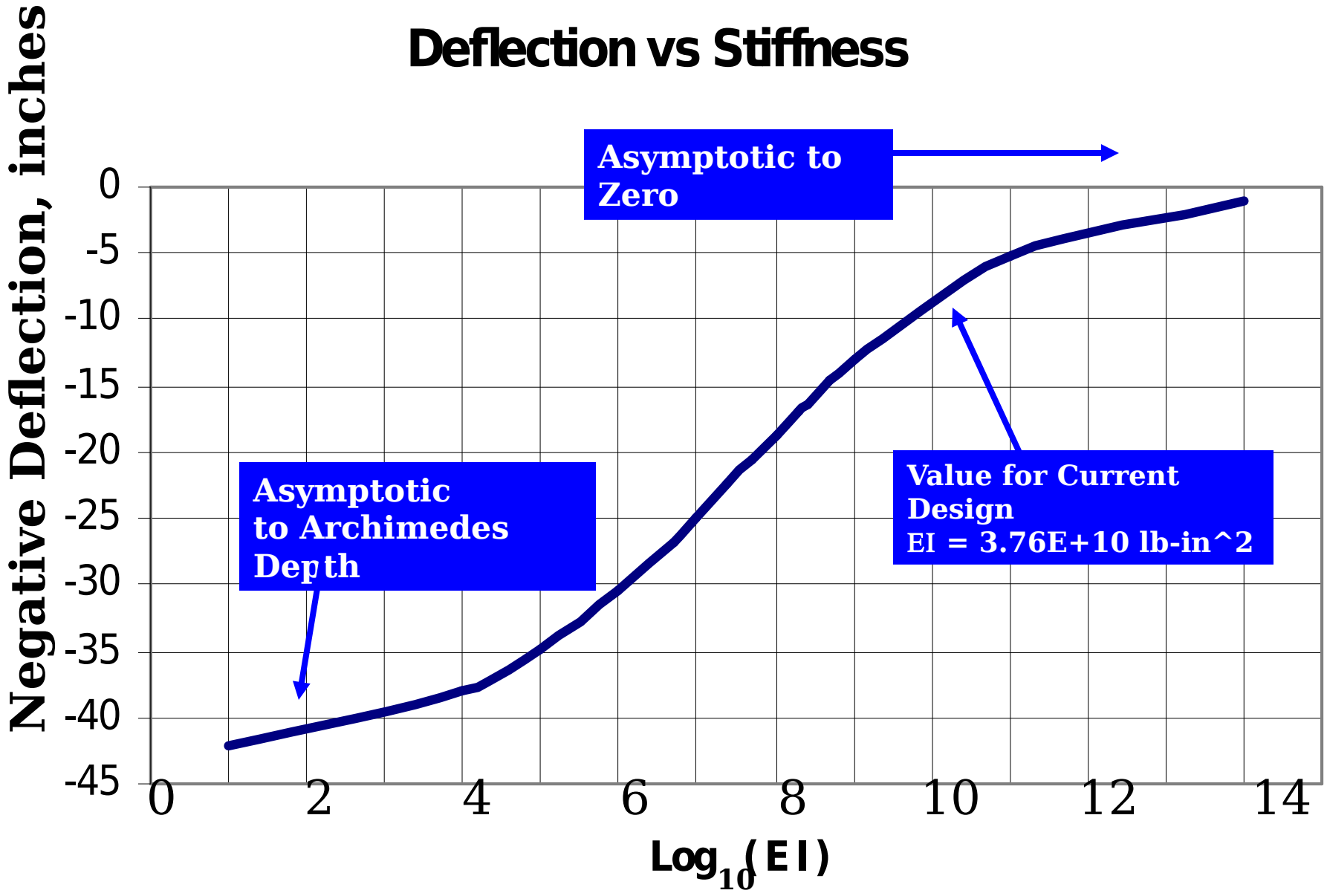
  - Small punctures → Slow pressure loss

- **Flat cable (strap) service life**

  - Material properties

  - Adjustable stiffness/compliance

Structural Stiffness

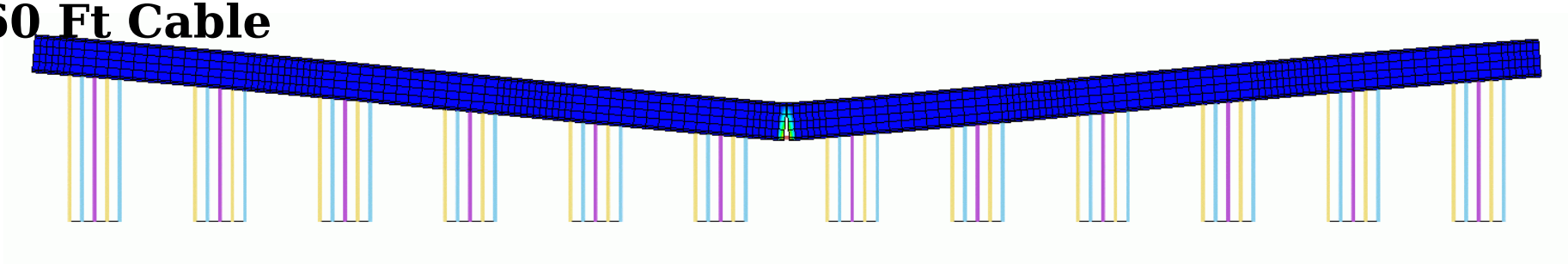


Flat Cable Candidates

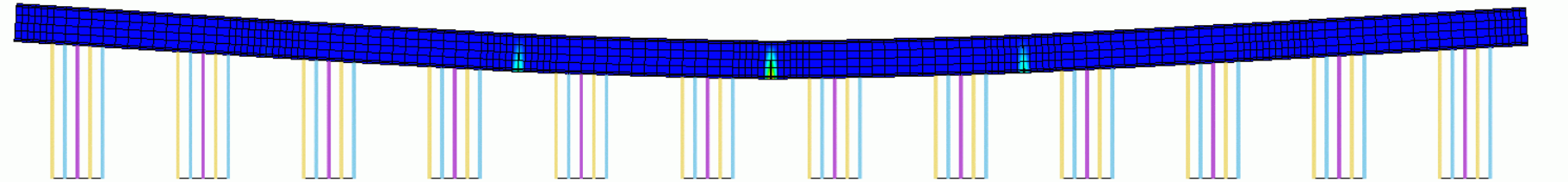
	Rope	Construction	Supplier	Material	Effective Tensile Modulus (psi, 10^6)	Specific Gravity (g/cm^3)
	Dyneema	Single Braid Torque Free	Sampson Ropes	Dyneema SK-75	5.66	0.98
	Spectra	Single Braid Torque Free	Puget Sound	Spectra 900	4.89	0.98
	Plasma	Single Braid Torque Free	Puget Sound	Spectra 900	7.24	0.98
*	Vectran	Single Braid Torque Free	Puget Sound	Vectran	5.71	1.40
	BOB	Single Braid Torque Free	Puget Sound	Spectra 900 (48%) Vectran (52%)	8.15	1.18
	Zylon	Double Braid Torque Free	Yale Cordage	Zylon (56%) Polyester (44%)	7.68	1.48
	Technora	Double Braid Torque Free	Yale Cordage	Technora (56%) Polyester (44%)	3.88	1.40
	Polyester	Double Braid Torque Free	Sampson Ropes	Polyester/Polyester	0.41	1.38
	Steel	6 by 36 Torque	WRCA	IWRC/XXIP	12.6	7.86
	Kevlar	3 or 4 Strand Torque	Whitehill	Kevlar 29	2.90	1.44

Effect of Cable Stiffness and Length

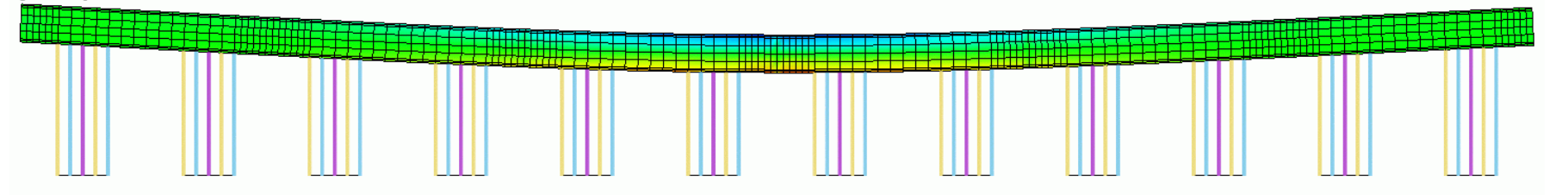
60 Ft Cable



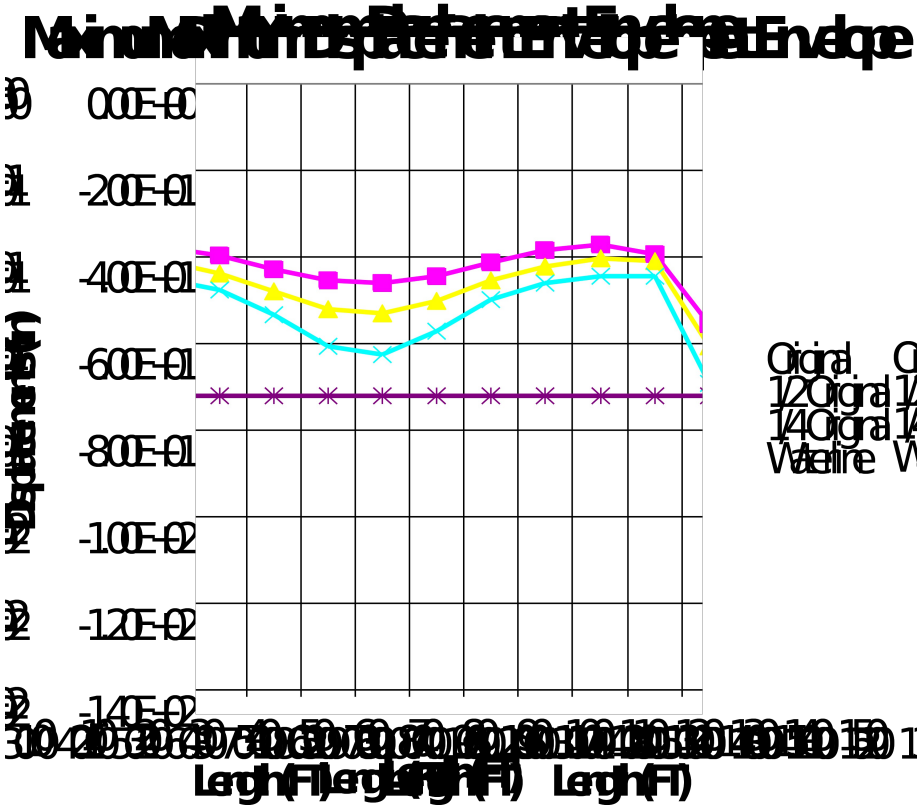
10 Ft Cables



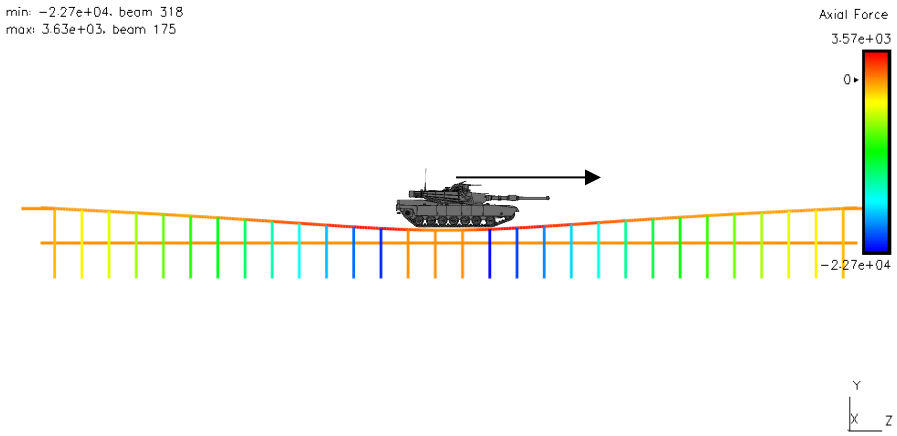
Solid



Floats Removed: 3

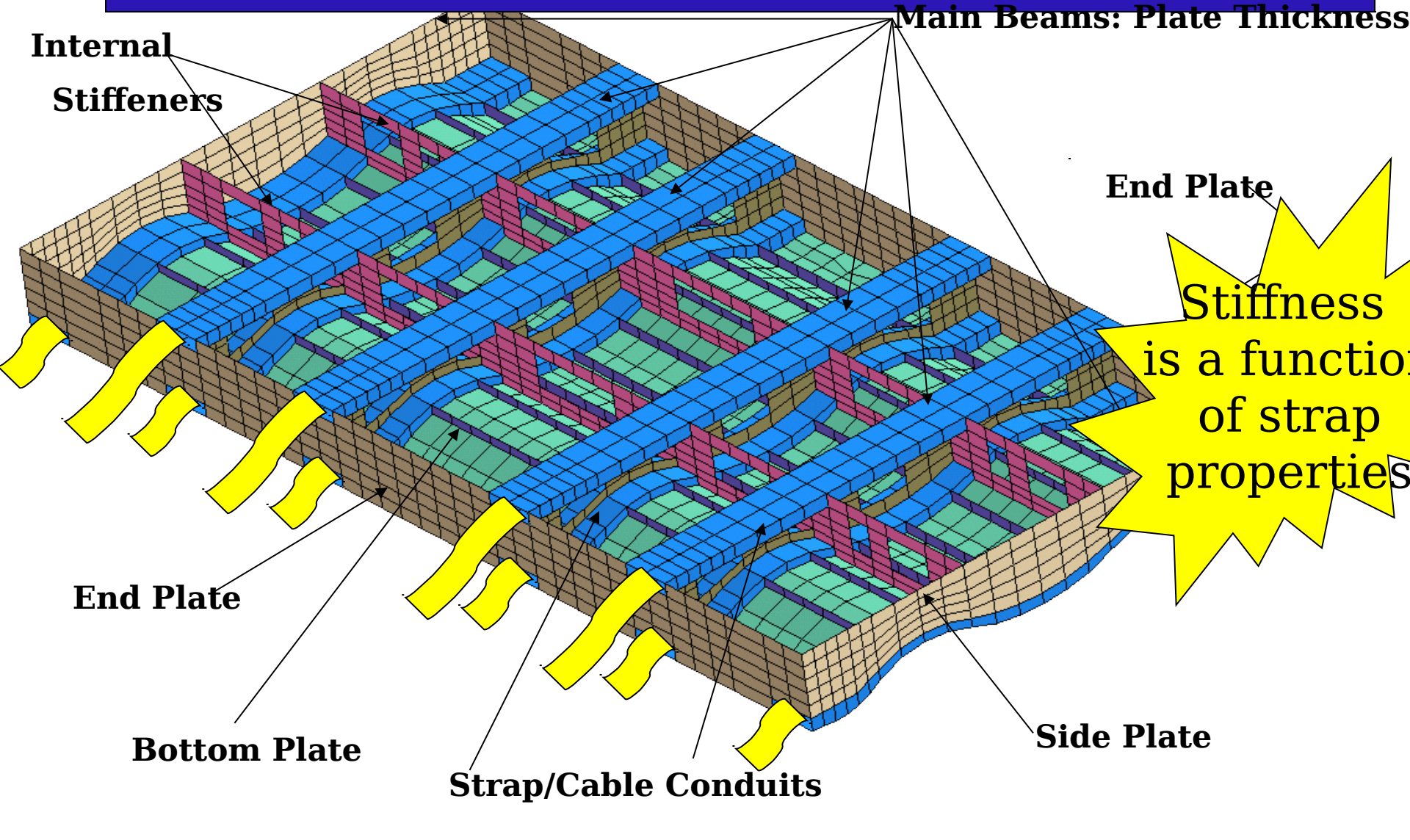


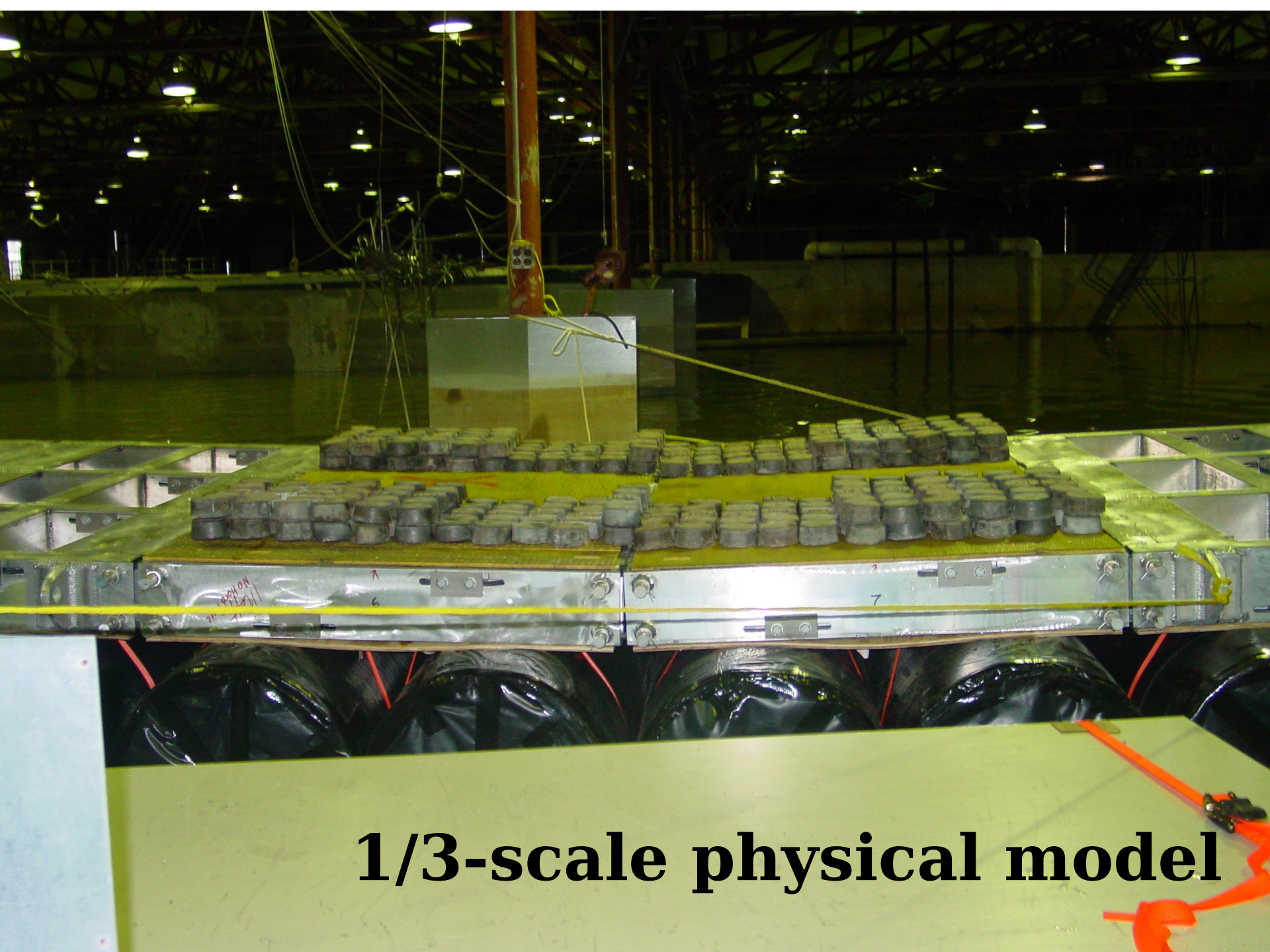
Even with 3 floats removed, positive freeboard is maintained



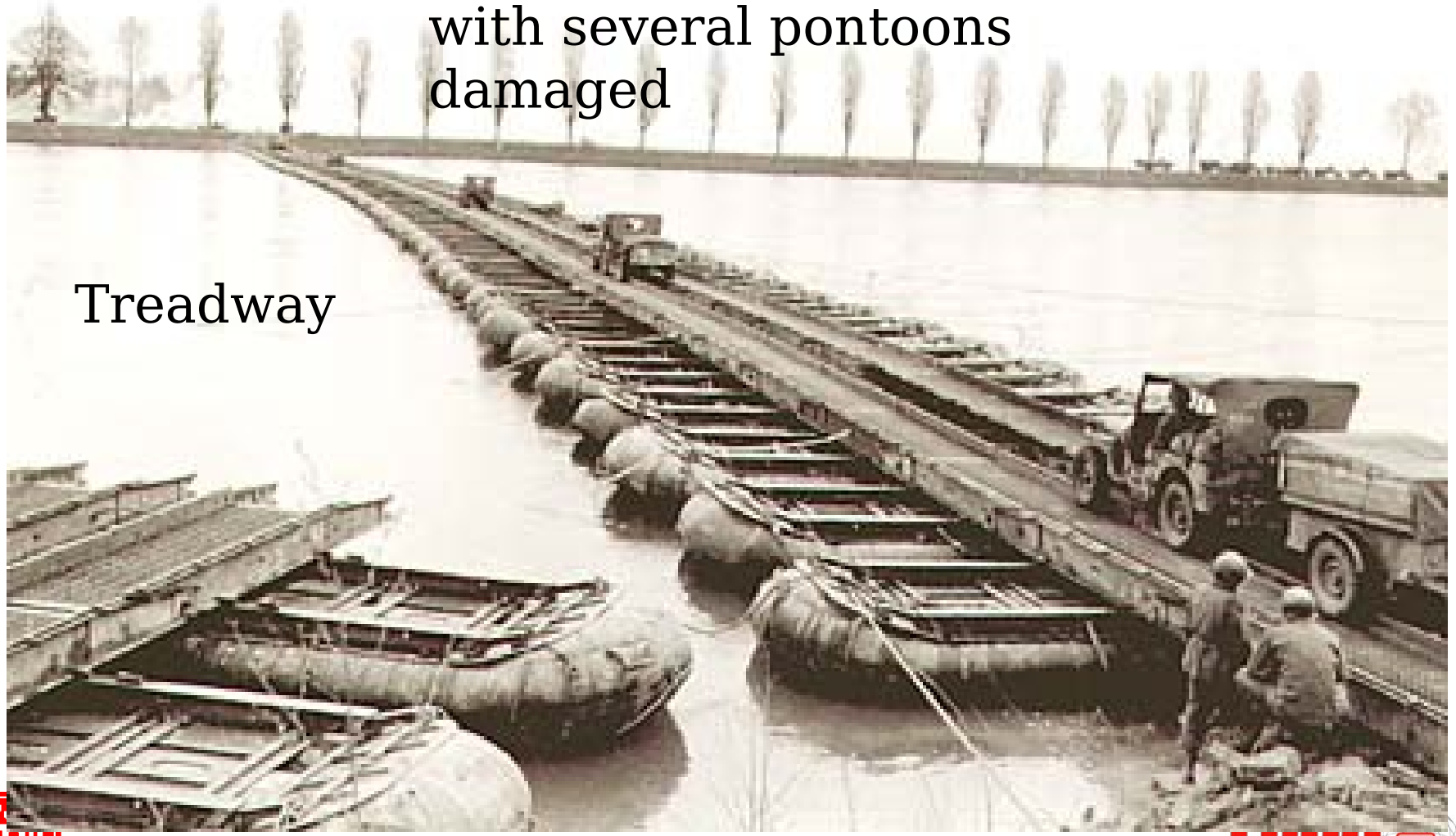
Structural Stiffness

Full Scale Design **All plate thicknesses except Main Beams = ¼ "**

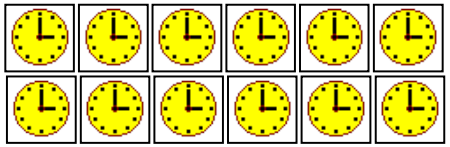
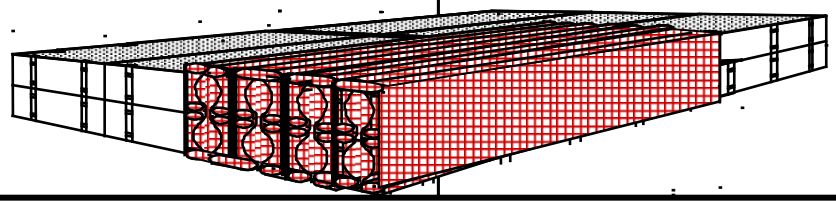



1/3-scale physical model

Remained functional even with several pontoons damaged



MCS VS LMCS

	MCS	LMCS
Assembly time		
Number of personnel required for assembly		
Supporting equipment required		
Space & Weight		

QUESTIONS?

Structural Stiffness

Stiffened section length relative to total length

- **Strap characteristics**
- **Breaking strength**
- **Elasticity considerations**
- **Shear/torsion rods**